The Changing Paradigm for Fiber-to-the-Home:
A Crucial Role for Electric Utilities

By

Steven R. Rivkin, Esq.
(Washington, DC: 202.783.7888; srrivkin@msn.com)
Remarks to the Fiber-to-the-Home Council, Semiahmoo, WA, July 10, 2003

For virtually my entire career in the "other Washington," deployment of broadband to the home has been the subject of intense controversy. Marvelous technologies can make high bandwidth commonplace. Coaxial cable, optical fiber, digitized copper, high-bandwidth wireless have all sharpened the consumer's appetite for cascading volumes of information – vast, fast, and versatile – rendering investments in older technologies and incumbent businesses precarious.

Yet, after more than a generation of struggle, there's no consensus as to who would own local broadband, how it should be regulated, and whether it should be open to any or all competition. So no technology has won out in the marketplace, major capital has yet to flow, and, regrettably, the best technical solution -- fiber to the home -– serves fewer than 40,000 residences.

Politicians and regulators have tried and mostly failed to break this continuing logjam. Remember Al Gore's quixotic "Information Superhighway?" Nothing better has come down the pike, and now there's a numb acquiescence in supposed choices by markets that are utterly dysfunctional, compounded by a sectoral slump in technology that has put a kibosh on many an innovation and most investment.

There is also a modest new F.C.C. initiative now to drop its own pro-competitive rules for last-mile telco fiber -- which this Council backs and to which several telcos have responded by promising to standardize future fiber procurements. But I don't need to tell you how iffy this could all turn out to be due in large part to the huge debt loads that continue to burden the telcos.

Nevertheless, a whole new suite of applications for local fiber may also be on the horizon, along with a new potential provider, just in time to shake the lethargy out of the stalled market. The applications I refer to involve local ELECTRIC service -- a pair of related transformations known as ***demand response*** and ***distributed power*** that will necessitate telecommunications links of some sort that probably don't exist today; the new provider could be the electric utility itself which must somehow make provisions for what I've called "adequate telecommunications support," on its own or through partnerships with other providers, incumbents included.

I. Two New Imperatives for Electric Service

The California energy crisis and the collapse of Enron have been catastrophes for the Nation's $250 billion electricity business. The scrutiny has been urgent and intense as to how to fix this key piece of the Nation's critical infrastructure. Re-examinations, made especially compelling by armed conflicts at the heart of the world's energy supplies and alarm over climate changes that are probably energy-related, have already achieved a consensus of informed opinion. This consensus[1] favors a pair of linked evolutions to greatly extend the reach and expand the functions of the local electric distribution utility.

Demand response aims to bring the choices of retail consumers in line with the continuously fluctuating price of wholesale power. In California two years ago, when wholesale prices were spiking as much as a thousand-fold, retail consumers had no way to know or heed the actual, time-varying costs of energy. So they couldn't curb their usage when it would have made sense to do so. The results were abrupt wide-area cut-offs of service that stranded people in elevators and left behind bills that

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[1] *See for example "Power to the People," by Vernon Smith, Wall Street Journal, October 16, 2002, p.A 20. Dr. Smith is the 2002 winner of the Nobel Prize in Economics.*

impoverished many customers, drove one big power company into bankruptcy, and today imperil the solvency -- and indeed (thanks to efforts to recall Gov. Davis) the political stability -- of the Nation's largest state.

Efforts at recovery led by California and encouraged by the Federal Energy Regulatory Commission have moved many states toward "demand response" strategies for future electricity markets. These strategies necessitate a direct two-way communications path of some sort between customers' meters and the utility, so that when energy prices rise and fall, consumers can and will respond, and then be billed accordingly.

In California, the PUC is hard at work trying to find cost-effective ways to do this statewide. Nevertheless, even in advance of knowing just how to do it, the principle of future reliance on demand response (or "DR") has already been adopted there and elsewhere in hopes of warding off another crisis, reflecting well substantiated expectations that DR can shave as much as 20% off of typical power bills.

Time-varying prices projected via telecommunications links are essential not just to incent more rational *demand*, but also to integrate newly popular plans for distributed power *supply* with central generation. "DER" (for <u>distributed energy resources</u>) has become mainstream

as an expedient to balance between energy and environmental imperatives. According to the U.S. Department of Energy,

> "Distributed generation…complements central power by: (1) providing a relatively low capital cost response to incremental increases in power demand, (2) avoiding transmission and distribution capacity upgrades by locating power where it is most needed, and (3) providing the flexibility to put surplus power back into the grid at user sites."

To illustrate how DER works in practice, assume you've made a decision to buy one of Alpha Technology's microturbines which you want to use most advantageously. When the price for power on the grid rises, you could decide to generate your own electricity. Or, you might want to sell some of your power back into the grid to get an attractive price or a credit on your bill.

In fact, a tremendous supply of consumer owned, back-up generation already exists, idling away as emergency standby power for hospitals, shopping centers, and high-rise buildings; many of these back-up generators could be profitably run more intensively to supplement central generation, if network connections were sufficiently hospitable and nimble. Likewise, many consumers will now be tempted to install their own renewable energy gear such as solar collectors, which are becoming cheap enough to produce electricity at marketable rates – especially for a blazingly sunny day,

when grid power truly priced would be most expensive due to spiking demand for air-conditioning. So fluctuating electric pricing made available via telecommunications to and from customers has become critical to technological evolution that is genuinely valuable and useful to consumers, the environment, and society as a whole.

Another instance where adequate data links will be critical to DER centers on the economic use of windpower, the world's fastest growing energy source, a great deal from one particular giant windfarm back over the mountains in western Oregon and maybe even more someday soon from out in Puget Sound. Since winds blow erratically, disparate renewable energy inputs and energy storage devices will also have to be bundled together with windpower into firm blocs of power.

Steady balancing is also becoming essential to assure smooth and reliable base power for our highly digitized economy. (The imperative to raise grid reliability above today's less-than-adequate "four nines" is well known. According to the Electric Power Research Institute, outages and power quality disturbances cost U.S. businesses more than $120 billion a year.) Locating supply near to consumption is one shrewd way to make the grid work better at a manageable cost -- and without having to build more transmission lines --, so the U.S. Department of Energy wants DER to make up at least 20% of all new power supply, substituting for central generation that could cost as much as $450 billion.

To illustrate how this shift to DER will impact on distribution utilities' needs for local telecommunications, I'm attaching two charts. Figure 1. I call a pigeon's eye view of grid components that need to be digitally linked. From central generation out to the local substation, today's utilities use a variety of highly controlled and shielded point-to-point communications devices -- wireless, powerline carrier, some fiber -- collectively called System Control and Data Acquisition (or "SCADA"), on which about $3.5 billion a year is spent worldwide. But between substation and the customers, there are few if any links, so far.

But not for long, because the future grid will require new interactive data flows from the local substation out to and from the individual residence. These links will connect various devices for consuming, producing, and storing energy that play only minor roles in today's energy economy.

Figure 2. is a schematic drawing Bonneville Power Administration prepared to illustrate its "Northwest Energy Web Initiative," which is unfolding right around us here today. Bonneville is the Pacific Northwest region's transmission and marketing authority for Federal hydro production. The graphic shows an electricity food chain remarkably evolved, relying on both DR and DER and embracing myriad nodes where power and telecom vectors go every which way, inexorably tied together.

If all goes according to the planning now underway, these new tendrils will become significant limbs of a greatly expanded grid. In designs for demonstrations to model electricity systems that will be in place in the second decade of this century, the U.S. Department of Energy suggests that as much as 50% of energy used in any particular area could be DER -- produced as well as consumed locally.

II. "Adequate Telecommunications Support"

It's not hard to grasp the magnitude of the tasks that local electric utilities will have to face in order to navigate all these transformations.

Start by recognizing that today's grid has only one-way energy flows, with all the power originating from a central source and cascading towards the ultimate consumer; there are very elaborate protections in place to assure the flow goes safely and dependably. Re-directing that flow to accommodate shut-offs and spontaneous inputs from myriad sources of distributed energy (some at or inside residences) will dictate a need for often instantaneous response to choices that do not originate with the utility itself. It will all depend on elaborate new networks of sensors, switches, and controls. These devices will need to be coordinated in real-time to assure, above all, the physical safety of shifting and complex traffic flows that reach across virgin territory, right to and within the residence.

That's why recently a bi-partisan national task force, called the Energy Future Coalition, "urgently recommend[ed] the development and deployment of a digitally controlled, fully networked transmission system that can accommodate decentralized generation."

The Coalition went on to call for deploying a "smart grid,… robust and secure" that will be "self-healing"…, "more secure from physical and cyber threats," that "will support widespread use of distributed generation," that "will enable consumers to better control the appliances in their homes and businesses," and that "will achieve greater throughput, thus lowering power costs…"

Likewise, a panel of experts convened by DoE's newly constituted Office of Transmission and Distribution recently concurred in the following broad vision of the electric enterprise, 25 years out:

> "[E]lectricity and information flowing together in real time, near-zero economic losses from outages and power quality disturbances, a wider array of customized energy choices, suppliers competing in open markets to provide the world's best electric services, and all of this supported by a new energy infrastructure built on superconductivity, distributed intelligence, clean power, and the hydrogen economy."

You don't have to grasp all the details, or be Ready Kilowatt, to see that very big changes are in the works.

These changes include the certainty that somehow the electric utility is going to have to build – or otherwise make provision for – data links to carry information to and from the residence that will drive critical evolving missions. Stated in the most value-neutral way, it will need what I'll call "adequate telecommunications support." Passing for now the identity of who provides that support, here's my own back-of-the-envelope list of its salient attributes. (Several demonstration projects are only just getting underway, sponsored by DoE, EPRI, and Bonneville, to write authoritative specs for "communications and controls.") Meanwhile, pencil in these attributes for what will constitute "adequate telecommunications support:"

- Universal Coverage. Considerations of efficiency as well as equity among classes of customers and individuals will require that critical data links don't have gaps in coverage. Also, both grid safety and reliability will demand pervasive coverage, starting with every electric meter in the community and extending throughout the disparate mix of Energy Web devices linked to the grid.

- High Reliability. Intermittent failures in communications would defeat the whole enterprise, whether from bad weather or electronic radiation, especially from signal interference caused by power lines themselves. The data support network will have to work perfectly virtually every time. And if the Nation turns to hydrogen for fuel, as enthusiasts ranging from environmentalists to the White House all hope, the system will have to monitor and control a highly volatile gas with complete authority.

- 24/7 Availability. Likewise, data communications for critical, always-on applications cannot be frustrated by busy signals or preempted by the vagaries of shared networks.

- Bi-directional, Real-Time Connectivity. Not only must price-signals go out to the customer, but data on usage and status from power-flow monitoring and control devices and remote sensors must come back to the utility, and there must be no appreciable time lag affecting activities and facilities that require tight co-ordination.

- High Security. Networked distributed generation and attendant power flows must be hardened against hacking and cyber-sabotage, which could cause havoc on a colossal scale.

- Privacy Protection. As with any shared network, individual customers will need assurance their data won't be compromised intentionally or inadvertently, and dedicated circuits will have to be sheltered from invasion by other users.

- Reasonable Cost. The huge economic value of electricity will cost-justify substantial capital investments in data communications infrastructure reaching the residence, but leasing out shared access could greatly reduce the costs that electric ratepayers will have to pay to assure the benefits of demand response and distributed generation.

So to what technologies – and what providers -- can electric utilities now look to fill their imminent needs for "adequate telecommunications support?" And what's the relevance of all this to fiber to the home?

III. Relevance to Fiber to the Home.

Until field tests are completed, my list is as good as any. This is so because both DR and DER are still mostly conjectural. So conceptual failings tend to go two ways: DR and DER are iffy because the requisite infrastructure, telecommunications included, is still unclear; and the infrastructure is unclear because DR and DER are still iffy.

To illustrate, even though the California PUC has accepted that it soon will rely on demand response, implementation so far lacks all specificity; this summer, isolated (and largely superfluous) tests are underway of individual consumer response relying solely on existing residential telecom links (none of which, alas, is likely to be fiber); so figuring out what data links and controls might be most appropriate to the tasks in view is being pushed to the future.

Similarly, the Department of Energy has just started to fund demonstrations of "communications and controls" technologies for DER, but DoE does not plan any large-scale field deployments until at least 2010. So if these laid back schedules are allowed to stand, real-world experience won't be brought to bear anytime soon to validate the seven attributes I suggest here will likely turn out to be absolute requisites for "adequate telecommunications support."

What's especially significant, I believe, is that all seven are also undeniable attributes of optical fiber. **If one asks whether any *other* technology is available for local telecommunications that could similarly fill the bill, the answer will be surprisingly clear: Coaxial cable, wireless, telephone, satellites, etc. will all suffer from one or more obvious failings. Only power-line carriage, which utilities already rely on for some SCADA (and which some utilities have recently begun to promote as a cost-competitive way to deliver high-speed internet to consumers), could conceivably meet the demanding service criteria I've stated for "adequate telecommunications support." And the results for PLC are still tentative and premature, and, with respect to new utility applications, utterly unsubstantiated. So, for now, at least, FTTH would have no equal.**

Interestingly, utilities that use powerlines for data communications – whether for SCADA today or service to consumers tomorrow – would be relying on their own legacy facilities. As such, PLC would serve as a pragmatic template for utilities that want to install their own fiber for any similar purpose. And, utility business plans that focus on either technology would prudently require that comparisons be made between the two in any future exploration of either one. Fiber enthusiasts here know which technology is bound to win out.

Significantly, while both technologies are capable of delivering high bandwidth, <u>bandwidth *per se* does not show up on my list of essential attributes for "adequate</u>

telecommunications support." Bandwidth would surely be beneficial, but, in the fiber case, high bandwidth would be merely incidental to the robust *other* attributes that utilities can prove they will actually need for DR and DER. Hence, any regulatory scrutiny of utilities' claims would have to credit as plausible their reasoning that they chose fiber for purposes other than general commercial telecommunications to the residence. And any suggestions of utilities' nefarious intentions with regard to exploiting the excess bandwidth would be, as we K-Street lawyers say, "eminently deniable."

IV. Practical Considerations Making Utilities Prime Candidates for FTTH.

That said, reasonable intentions would likely be presumed and eventually prevail – both for Investor-Owned Utilities ("IOU"s), which need to show state and federal regulators that all capital investment charged to electric ratepayers is "used and useful" in utility service and that all revenue earned from such investments is devoted to reducing the cost of service; similarly for the municipal and publicly owned systems (collectively "Munis"), which States – notably here in Washington – often require to stick to their knitting in order to preserve their bonding and tax-exempt status.

There's some precedent for optimism, though, that utility-built fiber used for DR and DER will sail through regulators' scrutiny. This would be because of the successful history of optical groundwire deployed in

transmission systems, of the sort manufactured by Guy Swindell's company Alcoa Fujikura. Tens of thousands of miles of this composite, an aluminum and/or steel sheath containing optical fibers at its core, see Fig. 3, have been deployed, mostly 125 feet up at the top of high-tension towers, often by helicopter. Since utilities use *some* of the fibers for internal communications and SCADA, the marginal costs of other fibers included in the cores are trivial when charged to ratebase.

Also, regulators seeking to encourage long-distance telecom competition by entities such as MCI and Sprint proved highly accommodating to the deployment of shared fiber in transmission lines. And it's no great technical feat to pack fibers into a powerwire, even a tiny one, see Fig. 4, such as two "Fiber to the Desk" products manufactured by Furukawa, one round and the other flat, used in congested office buildings.

Today's public policy imperatives facing state regulators (who supervise broken markets for telecommunications, as well as electric service) should be no less favorable for FTTH embedded in power networks. This follows from utilities' abilities now to show that robust data links are essential to DR and DER, as well as from prevalent dissatisfaction with the failure of telecommunications incumbents to deploy fiber in the last mile. Utilities, of course, must be willing to show responsiveness to public needs by devoting excess bandwidth to customer

service[2] – for instance, affording internet providers access to ultimate customers on an open, pro-competitive basis, like several Washington state munis do today with their FTTH networks.

Of course, it would solve the last-mile problem for sure if the incumbents would be willing to come aboard as tenants, or *"anchor tenants,"* if you will, on facilities owned by another entity (power companies) and largely paid for by electric consumers. I tried to craft just such arrangement a few years ago between a major IOU and a Bell ILEC, at the request of both sides. I got some great lunches, though no deals.

I can report, without revealing the identity of my luncheon companions, that the ILEC showed considerable interest in finding ways to share what we called "common infrastructure" built by another entity regarded as fairly benevolent. Penetrating to the core of the telco's intent, the telco recognized that it could reach each and every one of its customers without having to build its own facilities; it was especially eager not to have to pay union wages to its work force, as required by the "new technology" provisions of its labor contract with the Communications Workers of America! I had planned to show the telco how it could make and save bundles of money by

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2 Compare the March 7, 2003 Order of the Pennsylvania Public Utility Commission (G-00030997) authorizing PPL Telecom to use PPL Electric Corporation's distribution system "to provide information services to customers of PPL Electric using power line communications."

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renting rather than buying, which I never got to do. But I suspect the telco knew it could, and should, do just that.

And something similar can be said for many IOUs these days that have new reasons themselves to look at making local telecom investments. In about half the states, where deregulation was implemented a few years ago, utilities were allowed a "transition period" within which they could charge ratepayers their "stranded costs" -- costs for generating plants that weren't yet amortized but were considered unlikely to be paid off by consumers enticed by cheaper, competitive supplies of electricity. Now, many of these transition periods are coming to an end, and the utilities find their ratebases about to "fall off a cliff," as they say, ruining their future prospects of earning steady dividends for shareholders.

So, identifying new investments now to roll into rate base, especially if coupled with healthy with new income streams, could appeal to many IOUs that regard themselves likely to be whipsawed by competitive electricity markets they labored to bring about. Conversely, without bright prospects now for robust, competitive power markets, many regulators are under pressure to find ways to assure power supplies will still be adequate in the years ahead. So the door could very well open for IOUs to segue into local *telecommunications* investments they could show will enable *electric* markets to better serve consumers, specifically through DR and DER.

Unprecedented? For sure, which is ***not*** to say that it won't happen. What can be said with confidence is that electric utilities will soon need reliable data flows to

and from each and every residence, need that is becoming real, acute, and costly. That realization should give the Fiber to the Home Council reason to recognize promising new opportunities for just the kind of service FTTH can deliver. But it will still take some proverbial "skin in the game" to make sure it all does happen.

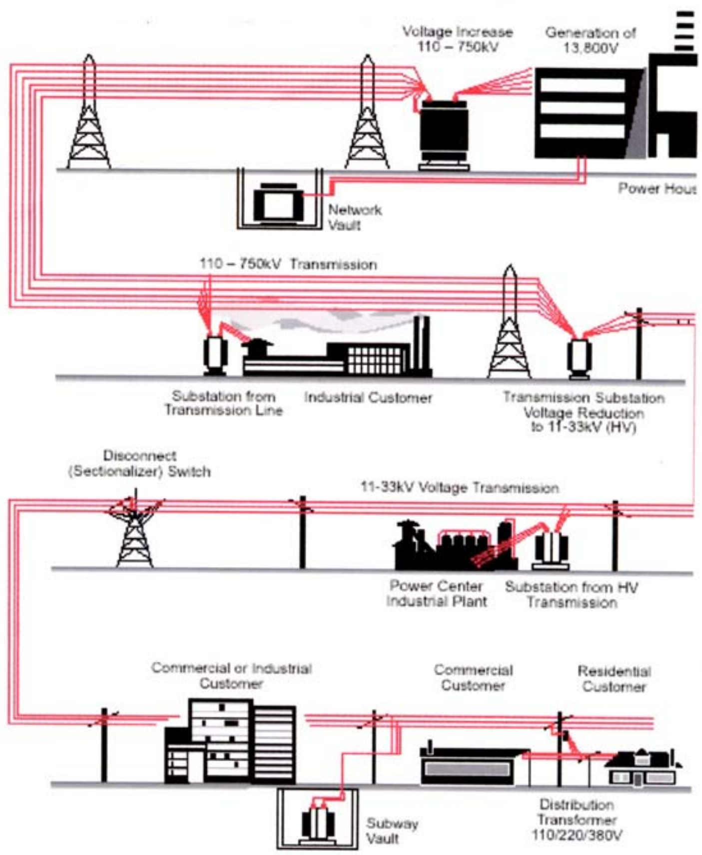


Fig. 1. Electric Grid, Pigeon's Eye View

Source: SPIRAE

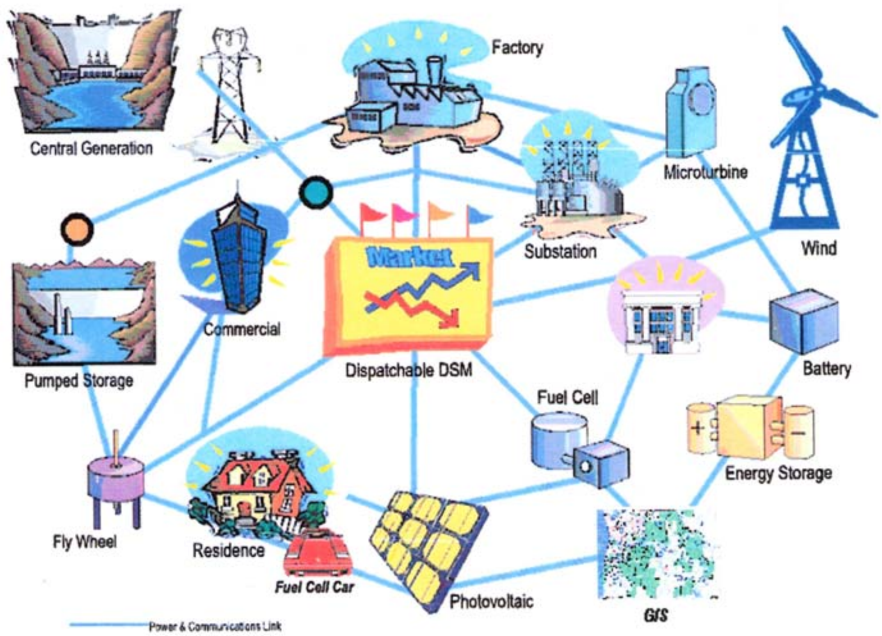
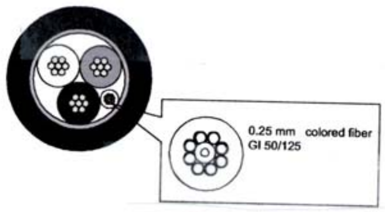


Fig. 2. Energy Web, Schematic View

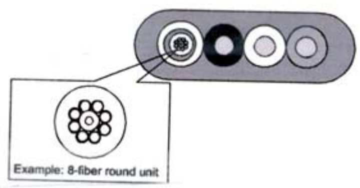
Source: Bonneville Power Administration

Fig. 3. Optical Ground Wire ("OPT-GW")

Source: AFL Telecommunications



("FTTD" – Round)



("FTTD" – Flat)

Fig. 4. "Fiber to the Desk"

Source: Furukawa Review